The Reaction Kinetics of Methane Hydrate Dissociation in Porous Media

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RESEARCH OBJECTIVES

The objective of this study is to describe the kinetic dissociation of CH_4-hydrates in porous media, and to determine the corresponding kinetic parameters. Knowledge of the kinetic dissociation behavior of hydrates can play a critical role in evaluating the gas production potential of gas-hydrate accumulations in geologic media.

APPROACH

We analyzed data from a sequence of tests of CH_4-hydrate dissociation by means of thermal stimulation. These tests had been conducted on sand cores partially saturated with water, hydrate, and CH_4 gas, and contained in an x-ray-transparent aluminum pressure vessel. The pressure, volume of released gas, and temperature (at several locations within the cores) were measured. To avoid misinterpreting local changes as global processes, x-ray computed tomography scans provided accurate images of the location and movement of the reaction interface during the course of the experiments. After first determining the thermal properties of the hydrate-bearing medium, we obtained estimates of the kinetic parameters of the hydration reaction in porous media by means of inverse modeling (history matching) of the laboratory data, using the TOUGH-Fx/Hydrate code. Comparison of the results from the hydrate-bearing porous media cores to the known kinetic parameters of dissociation of pure CH_4-hydrate samples provided a measure of how the porous medium affected the kinetic reaction.

ACCOMPLISHMENTS

This is the first-ever determination of the kinetic parameters of hydrate dissociation in porous media. The excellent agreement between observations and numerical predictions validated the kinetic parameters determined through the inversion process, confirmed the hypothesis of their intrinsic character (and, thus, of their invariant values), provided increased confidence in (and further verification of) the numerical model used to describe the hydrate behavior in porous media, and indicated that the thermal conductivity model (developed as part of a related study) was not inconsistent with the overall system behavior.

SIGNIFICANCE OF FINDINGS

Knowledge of the kinetic rate of dissociation for gas hydrates is of critical importance in predicting the rate of gas production from natural hydrate accumulations, because it can provide an estimate of their technical and economic viability as potential energy sources.

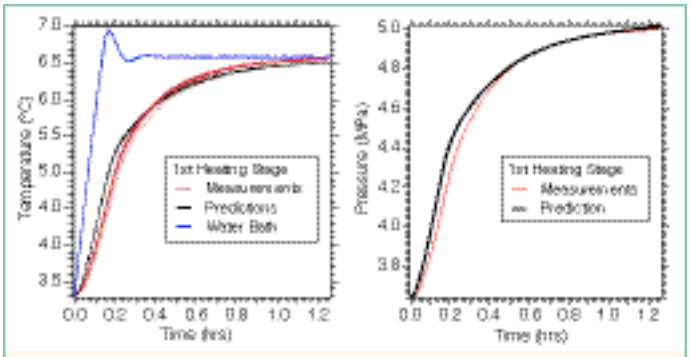

Figure 1. Comparisons between the evolution of the observed and predicted (based on the new estimates of kinetic dissociation) temperature and pressure in the hydrate-bearing core samples

RELATED PUBLICATIONS

Kneafsey, T., L. Tomutsa, G.J. Moridis, Y. Seol, B. Freifeld, C.E. Taylor and A. Gupta, Methane hydrate formation and dissociation in partially saturated sand—Measurements and observations. Proceedings of the 5th International Conference on Gas Hydrates (in press), Trondheim, Norway, June 13–16, 2005. Berkeley Lab Report LBNL-57300.

Moridis, G.J., Y. Seol, and T. Kneafsey, Studies of reaction kinetics of methane hydrate dissociation in porous media. Proceedings of the 5th International Conference on Gas Hydrates (in press), Trondheim, Norway, June 13–16, 2005. Berkeley Lab Report LBNL-57298.

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